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ABSTRACT

Discussed in this monograph are energy circumstances in the United States and the role two-year colleges can play in meeting future demands for energy technicians. Sections 1 through 4 offer perspectives on U.S. energy use, legislation, labor force projections, and two-year colleges. Some major program concerns appear in Section 5, while Section 6 identifies information resources for program funding. The appendix includes a bibliography. (Author/WB)

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Energy Education Programs:

Perspectives for Community, Junior, and Technical Colleges

SE 034 175

American Association of Community and Junior Colleges

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Energy Education Programs:

Perspectives for Community, Junior, and Technical Colleges

by

Mary Ann Settlemire

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One Dupont Circle, N.W.
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Introduction

Energy is an ubiquitous concern today. While President Carter's description of the Administration's approach to the issue may be overdrawn ("the moral equivalent of war"), the impact of the nation's energy problems is in many respects like the impact of war. It affects everyone. It is on everyone's mind. It creates emotional responses, and it stimulates a chauvinism, a drive toward self-reliance, on both the national and individual levels.

When we fill our auto tanks, when our home heating and cooling bills arrive, when we purchase goods and services of any kind, and when we are told that approximately 85 billion American dollars will be spent this year to purchase foreign liquid fuels, we recognize the magnitude of the problem and its effect on us.

Evidence of America's response to energy circumstances appears in recent federal legislation and in escalating citizen demand for energy-efficient homes, appliances, automobiles, and office buildings.

In increasing amounts, public and private monies are being channeled for research and demonstration activities designed to address energy problems. Monies are also being committed, although in lesser amounts, to support energy education programs. The programs have at least three purposes: to clarify the energy shortage situation for local residents and to show how they can contribute to solutions, to train or retrain technicians for existing energy-related businesses and industries, and to prepare technicians for those energy occupations that are likely to emerge in the near future.

The nation's colleges—especially community, junior, and technical colleges—are playing and will continue to play an important role in these national efforts. Historically, two-year colleges have not only responded quickly to the needs of their local communities, but the colleges have also had the vision to anticipate training and education needs before they are clearly defined by others, and they have acted upon their vision.

There is a risk in responding to vision, and a danger in not responding to it. The risk is that colleges that train energy specialists before there is a clear manpower demand for them may be training persons for jobs that do not exist or, worse, for unemployment. The danger is that if colleges do not establish training programs responsive to their vision, emerging energy industries may go begging for technicians, a situation that will slow the development of the industries.

Like all dilemmas, the solution to this one is thorny. This monograph advises the cautious, conservative approach: Do not train narrowly-focused energy technicians for jobs that do not currently exist. It further advises that energy options be offered in standard, related curricula so that as energy manpower needs are clarified, technicians can easily and quickly move from one occupational focus to another. A third suggestion is

that the college's projections for energy manpower needs be shared with local business and industry leaders as a means of testing the projections against private sector experience and expectations, as well as planting the idea that trained energy personnel are needed by local business and industry. Planting the idea may serve as a marketing strategy for future programs.

As noted frequently in this monograph, expansion in the energy field is occurring so fast that predicting the future needs with any certainty is nearly impossible. However, some trends are clear and some directions that can be taken are obvious. The uncertainties and the obvious directions are noted in the monograph.

While most of the material in the monograph is derivative, some of it was generated through conversations with college faculty and administrators who are responsible for established energy education programs. The purpose in both cases is to provide colleges with information that may be useful as reference in an energy education course and helpful in establishing, improving, or expanding a program. Sections 1-4 offer perspectives on U.S. energy use, legislation, manpower projections, and the roles of two-year colleges. Section 5 presents some major program concerns and problems. Section 6 identifies some important information resources for program funding. A bibliography appears in the Appendix.

A useful companion document is being prepared by the AACJC Energy Communications Center. The *Directory of Community/Junior/Technical College Energy Programs* contains brief descriptions of energy education activities at more than 500 institutions. Each college record includes a program description; contact person name, address, and telephone number; and identification of the source of the information. The *Directory* will be available in January 1981 through the Association.

Finally, as has already been noted, the principal purpose of this monograph is to present a perspective on energy circumstances in this country and on the role two-year colleges can play. Like most perspectives, a lineal, objective view is presented. Little attention is given to the subjective charge that energy issues carry with them. Little is said about the great potential colleges have in leading their communities (the private citizen, the corporate and public worlds, and the small businesses, among others) toward greater energy efficiency and energy self-reliance. Education resource materials like this are traditionally conservative. Yet, it would be a disservice not to underscore the significant contributions two-year colleges have made already—and the risks they have taken—in alcohol fuel production; solar heating and cooling systems and photovoltaics; wind energy conversion mechanics; mining; petroleum production; and nuclear power. The energy field may be the most exciting, challenging education field today. The excitement should not be lost in the straightforward, reasonable presentation that follows. The intent of the monograph is not to create the excitement, but to provide background materials upon which local college enthusiasm might be generated.

James R. Mahoney
Project Director
Energy Communications Center

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1 History of Energy Use in The United States

Coal, America's most abundant fossil fuel, was the foundation of the country's energy resources for over two centuries. It moved America from an agrarian to an industrialized society, and strongly contributed to the country's economic growth. In the late 1940's and early 1950's, however, coal was pushed aside in favor of cheaper and more convenient fuels like oil and natural gas.

The first gas company in the United States was established in Baltimore, Maryland, in 1816, with similar gas companies organizing rapidly over the next two decades. The first large-scale use of manufactured gas in the early 19th century in America was for street lighting. Large-scale use of gas for cooking did not occur until late in the 19th century.

Toward the end of the century, high-cost manufactured gas met ever sharper competition from cheap kerosene for household lighting, and from electric arc lamps for street lighting. Soon thereafter, central electricity-generating stations were developed, and electricity began to compete for the entire lighting market. As the competitive situation stablized in the early 20th century, the manufactured gas industry was left with only the market for residential cooking and water heating.[1]

Even this market was eventually replaced through the use of low-cost natural gas, which was found primarily in the South and Southwest, and in limited quantities in the West and Midwest. Natural gas was generally a local fuel until after World War II. Technology developed during the war led to the transport of natural gas by pipeline over long distances, connecting the Southwest, Gulf Coast, and Appalachia to all of the country's metropolitan areas.

Eventually, natural gas came to be widely used for residential and commercial space heating and for a variety of industrial purposes, especially as boiler fuel.[2] In the 1950's, gas was so cheap and so abundant that producers considered it a by-product in their search for oil and often flared it. Often, oilmen who found gas instead of oil would curse their luck![3]

The oil industry had its origins in the mid-nineteenth century, when kerosene began to replace expensive whale oil as a source of interior lighting. Most kerosene was extracted from coal, but some was extracted from crude oil. Until 1859, crude oil could be obtained only where it naturally seeped to the surface or from brine water wells. The expense of kerosene, $42 a barrel, led to explorations to find cheap and easily available supplies of crude oil.[4]

In 1859 a railroad conductor named "Colonel" Edwin Drake was hired by a group of New Haven investors to drill for oil in the vicinity of brine wells in Pennsylvania. He had neither business nor drilling experience, and was not a colonel. However, he was employed and possessed a railroad pass that allowed him free transportation. The investment gamble paid off. Drake stuck oil on August 27, 1859, near Titusville, Pennsylvania.[5]

By 1909 U.S. oil production had reached 500,000 barrels a day, more than the rest of the world combined. Not until 1948 did imports of foreign oil exceed exports of American oil.[6]

Production of American oil was expensive, and the U.S. found it increasingly difficult to compete with low-cost crude oil flowing in great quantity from the Middle East, beginning in the 1950's. Import restrictions were introduced in the late 1950's to limit incoming foreign oil, but the demand for oil, no matter what its origin, kept rising.

In 1970 U.S. production peaked at an average of 11.3 million barrels of oil a day. Cheap imported oil took a larger and larger share of the U.S. oil market as demand grew.[7] From 1950 until 1973-74, when world oil prices quadrupled, U.S. comsumption of energy increased at an aveage annual rate of 3.5 percent. As a result of the availability of cheap energy, the U.S. developed a stock of capital goods—such as homes, cars, and factory equipment—that used energy inefficiently.[8] By 1979, the United States was expected to have to import 47 percent of its total oil consumption.[9] (See Figure A)

Today, the high cost of oil, the resulting effects on the dollar, and the supply interruptions all impact on the American economy and lifestyle. The President and the Congress, therefore, have chosen to return to America's most abundant energy resource—coal—as well as to develop and use alternative energy resources and to encourage solar applications and conservation.

Coal mining was not a major world industry until the 18th century and the advent of the Industrial Revolution. In the United States, explorers discovered coal in 1673, but mines were not opened and operated until the 1740's in Virginia, and not until the 1750's in Ohio. Pennsylvania mines were opened in about 1790.

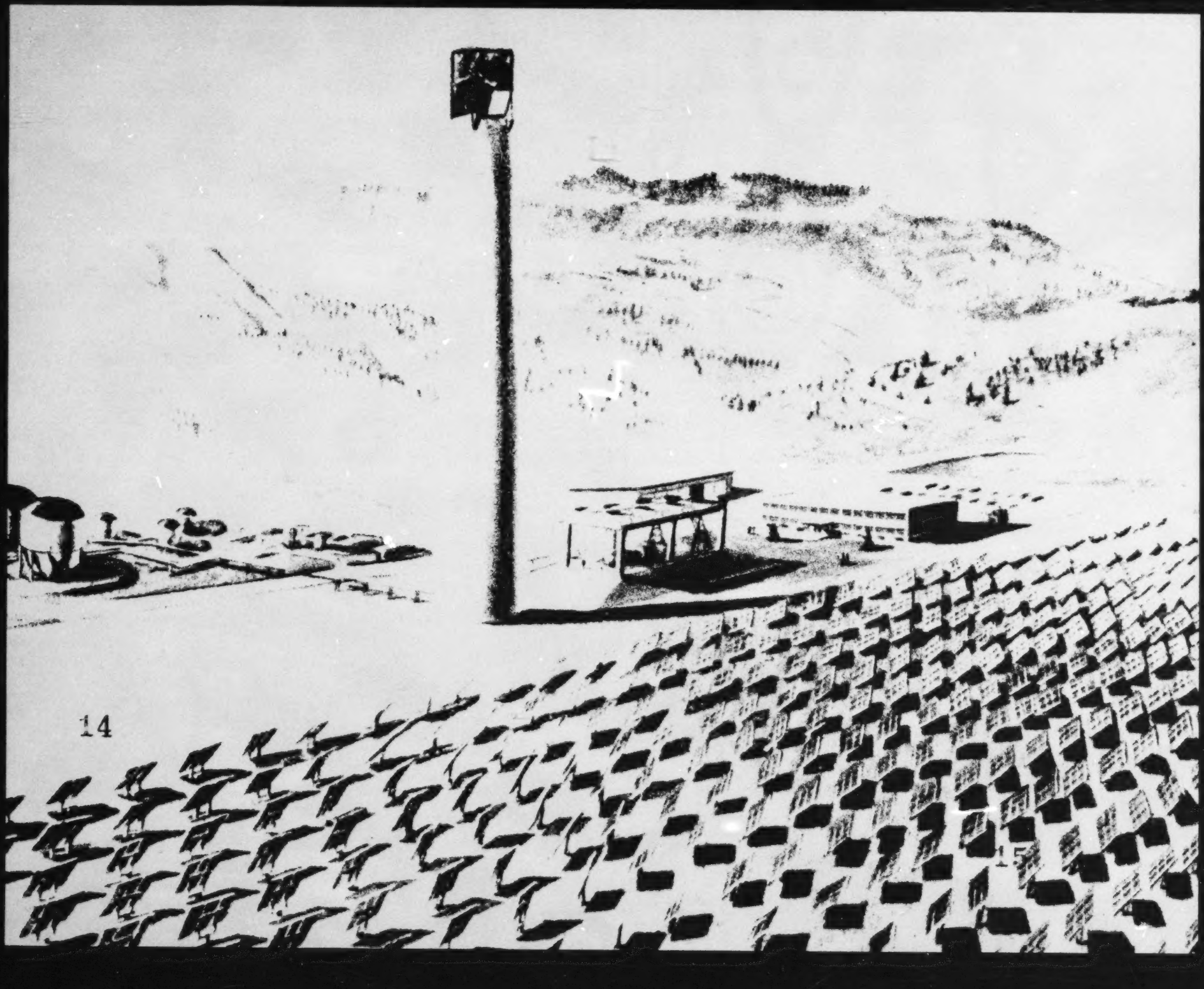
Coal furnished 90 percent of the natural energy until about 1900, even though important reserves of oil and gas had been developed in the 19th century. From 1900 to 1929 the expansion of the oil market was largely at the expense of anthracite coal mines. Bituminous coal continued to provide 70 percent of U.S. energy through World War I. By the mid-1930's, however, bituminous coal production (such as that mined in Ohio), provided only 45 percent of the country's mechanical energy. Except for a brief hiatus during World War II, the downward trend of the coal industry continued at an irregular pace until today.

Foreign Oil Consumption in the U.S.				
Year	Consumption (millions of barrels a day)	Production (millions of barrels a day)	Imports (millions of barrels a day)	Imports (as a percentage of consumption)
1960	9.7	8.0	1.8	19%
1962	10.2	8.4	2.1	21
1964	10.8	8.8	2.3	21
1966	11.9	9.6	2.6	22
1968	13.0	10.6	2.8	22
1970	14.4	11.3	3.4	24
1972	16.0	11.2	4.7	29
1974	16.2	10.5	6.1	38
1976	17.0	9.7	7.3	43
1979 (est.)	19	10	9	47

Figure A[10]

About 26 percent of the world's coal reserves are in the United States, with the largest portion in the Soviet Union (41 percent). In 1979, the U.S. produced 776 million short tons of coal, up from 685 million in 1976.[11] The Venice Economic Summit in 1980 led to an agreement among the participating countries (United Kingdom, France, Germany, Japan, Italy, Canada, United States, and the European Economic Commission) to double coal production and use by early 1990.

The emphasis on coal, as well as other alternative energy sources, is outlined in the following description of recent U.S. energy plans and legislation.



2 Energy Legislation

The National Energy Plan

In 1977 President Carter formulated the National Energy Plan (NEP) to phase down the use of petroleum in the United States and to increase the use of alternative energy sources. The President outlined three overriding objectives designed to:

- reduce dependence on foreign oil and vulnerability to supply interruptions;
- keep U.S. imports sufficiently low to weather the period when world oil production approaches its capacity; and
- maintain renewable and essentially inexhaustible sources of energy for sustained economic growth.

The salient features of the NEP were:

- conservation and fuel efficiency;
- rational pricing and production policies;
- reasonable certainty and stability in government policies;
- substitution of abundant energy resources for those in short supply; and
- development of nonconventional technologies for the future.[12]

The NEP was designed to reverse the trend of ever-rising oil imports and ever-increasing American dependence on uncertain foreign sources of supply. It would prepare the United States for the time when the world faced a limitation on oil production capacity and consequently skyrocketing oil prices, and would achieve substantial energy savings through conservation and increased fuel efficiency, with minimal disruption to the economy. It would also stimulate the use of coal in a manner consistent with environmental protection.[13]

The National Energy Plan set forth goals for 1985 that could be achieved with the willing cooperation of the American people. The goals were:

- reduce annual growth of total energy demand to below 2 percent;
- reduce gasoline consumption 10 percent below its current level;
- reduce oil imports from a potential level of 16 million barrels per day to 6 million, roughly one-eighth of total energy consumption;
- establish a Strategic Petroleum Reserve of 1 billion barrels;
- increase coal production by two-thirds, to more than 1 billion tons per year;
- bring 90 percent of existing American homes and all new buildings up to minimum energy efficiency standards; and
- use solar energy in more than $2\frac{1}{2}$ million homes.[14]

The plan provided for conservation initiatives to reduce demand in the transportation sector and to reduce energy waste in existing buildings. It contained a program for utility reform.

It stated that government policy should provide for prices that encourage development of new gas and oil fields with a more rational pattern of distribution and should prevent windfall profits.

The coal industry was addressed in the NEP through a strong regulatory program prohibiting all new utility and industrial boilers from burning oil or natural gas, except under extraordinary conditions. The conversion by industry and utilities to coal and other fuels would be encouraged by taxes on the use of oil and natural gas.

Nuclear and hydroelectric power, solar energy and geothermal energy were also addressed in the plan. The policy was "to defer any U.S. commitment to advanced nuclear technologies that are based on the use of plutonium while the country seeks a better approach to the next generation of nuclear power than is provided by plutonium recycle and the plutonium breeder."[15]

The Department of Defense, through its Corps of Engineers, and in concert with other agencies, was to "report on the potential for installation of additional hydroelectric generating capacity at existing dams throughout the country."

The NEP included a proposal to stimulate the development of a large solar market through the use of a tax credit supported by a joint federal-state program of standards development, certification, training, information gathering, and public education. A tax deduction for intangible drilling costs available for oil and gas drilling would be extended to geothermal drilling.

National Energy Act

In November 1978 five separate pieces of legislation were signed into law by the President and combined to become the National Energy Act. These were:

1. The National Energy Conservation Act—Provided for regulation of interstate commerce to reduce the growth of demand for energy through energy conservation and the development of solar and other alternative energy sources.
2. The Power Plant and Industrial Fuel Use Act (Coal Conversion Act)—Promoted the use of fuels other than oil and natural gas in the production of energy in new and existing electric power plants and other major fuel burning installations.
3. The Public Utility Regulatory Policies Act—Altered price and other regulations on public utilities to encourage conservation and efficient use of electricity and to improve wholesale distribution of electric power while maintaining equity in the rate structure.
4. The Natural Gas Policy Act—Eliminated the distortions caused by two-tiered (interstate/intrastate) pricing of natural gas and removed "outmoded regulatory burdens" associated with sales in interstate markets.
5. The Energy Tax Act—Provided for tax incentives consistent with the purpose of the National Energy Conservation Act and the Coal Conversion Act.[16]

National Response Plan

In April 1979 President Carter implemented a National Response Plan (NRP) to reduce petroleum consumption by up to 5 percent. The NRP was the result of a commitment the United States made to the International Energy Agency (IEA) in March 1979 to help offset the world's shortfall brought about by reduced oil production in Iran. The 20 member countries of the IEA entered into the agreement to prevent shortfalls, to stabilize the world oil market, and to reduce pressures for premium oil prices. The U.S. obligation under the agreement was to reduce demand for oil imports by up to 1 million barrels per day by the end of 1979.

The NRP was designed to meet the IEA commitment to reduce oil demand, to minimize pressures on world prices, and to

avoid oil supply problems later in the year. It contained a graduated set of measures to be implemented as necessary to meet the IEA commitment and to deal with potentially more severe shortfalls:

- Each state was urged to implement plans to reduce gasoline consumption.
- State governments were requested to reduce their direct use of gasoline, and to control government building temperatures.
- All Americans were requested to reduce their total oil consumption by reducing discretionary driving using carpools and mass transit, making thermostat adjustments, and others.
- Federal agencies were directed to reduce use of gasoline for government vehicles, control building temperatures, encourage employee use of carpools and mass transit, and to charge full commercial rates for parking spaces provided by the agencies in urban areas.
- Large utility, industrial, and commercial users were urged to switch from oil to natural gas.
- Electric utilities were encouraged to transfer excess electricity from coal and hydro power plants to utility systems relying on oil fired plants.
- Mandatory building temperature controls were to be enacted by Congress at no more than 65° in the winter and no less than 80° in the summer.
- Environmental Protection Agency was to modify its requirements for the phasedown of lead in gasoline.
- Waivers for state standards under the Clean Air Act were to be considered by the President if appropriate due to shortages of low sulfur fuel oil.
- Refiners were requested to establish targets to rebuild distillate fuel oil stocks.
- DOE was to direct large refiners to sell crude oil to the small refiners to avoid severe inequities.[17]

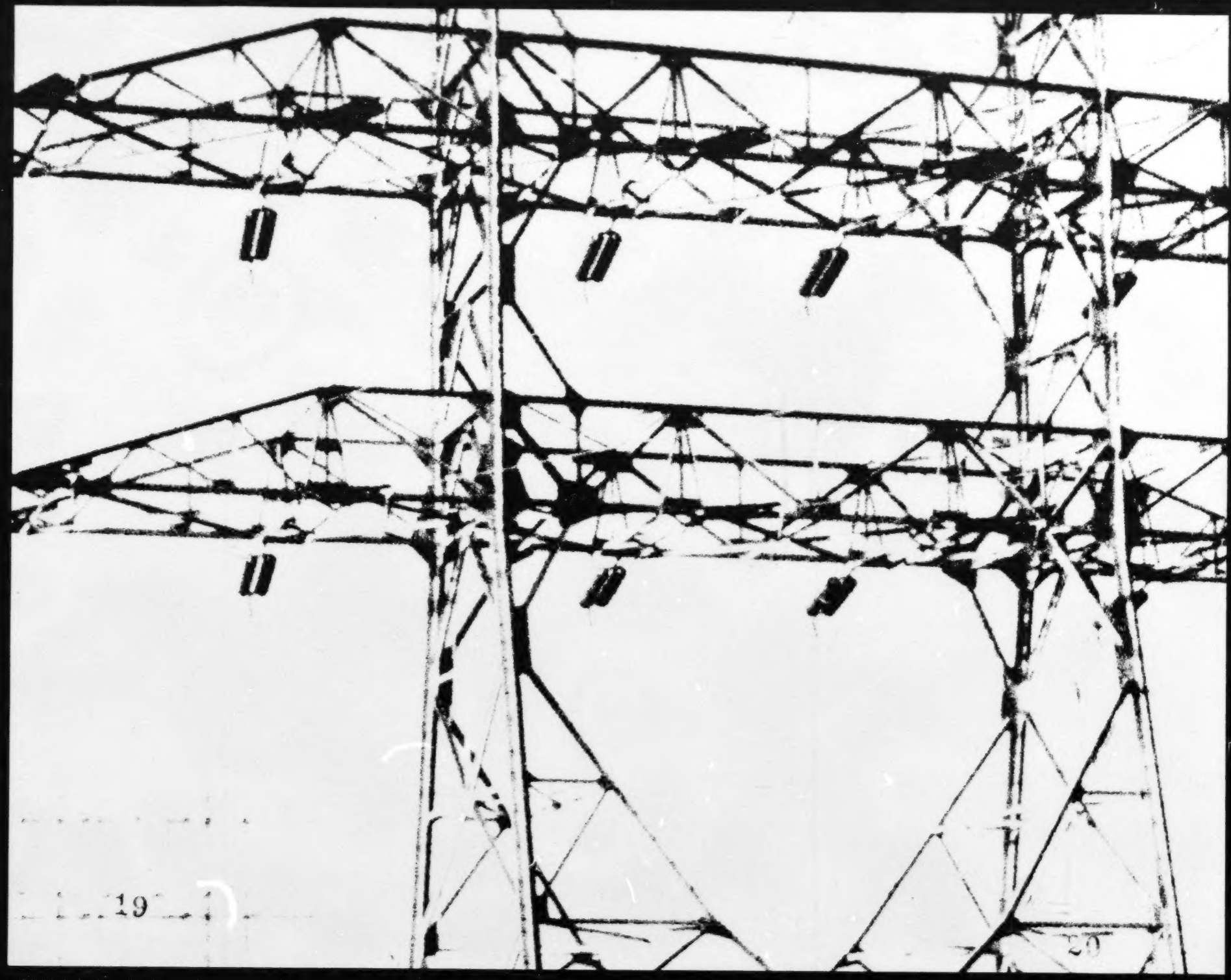
Energy Security Act

In June 1980 President Carter signed the Energy Security Act into law. It provided for:

- The establishment of a Synthetic Fuels Corporation to stimulate the production of 2 million barrels per day of synthetic fuels by 1992.
- The establishment of a Solar Energy and Energy Conservation Bank with authority to provide monetary incentives to spur energy conservation and renewable energy investments.
- Biomass financial assistance programs designed to assist the production of alcohol fuels and fuel from biomass and municipal waste.
- Statutory support for electric and gas utility investments in energy conservation.[18]

Backup measures including gas rationing, mandatory actions to require major utility and industrial users to switch from oil to natural gas, restricted gasoline sales for all or parts of weekends, and others were included in the Response Plan.

These three measures—the National Energy Plan, National Energy Act, and National Response Plan—have had a direct effect on the energy industry. It is expected that the Energy Security Act will impact the industry as well.



3 Energy Manpower Projections

The particular effects of national energy policies on education, training, and employment may be impossible to forecast accurately. The federal government's uncertain commitment to alternative energy sources complicates the matter. However, some substantive (if tentative) forecasts have been made in the last few years. A summary of these projections is presented below.

Coal

The coal industry is a regional industry. Underground mining is primarily located in the Appalachian states of Pennsylvania, Virginia, West Virginia, and Kentucky. Surface mining in the West is almost exclusively found in Wyoming and Utah. The coal industry does, and wants to do, most of its own training. Institutions that have mining mineral curricula have found that they have been unable to place the vast majority of their graduates, or that the industry has hired the students prior to graduation. Others have found it necessary to diversify and not limit training to the coal industry, but to include uranium, for example.

A recent coal mining manpower report concluded that employment growth rates are moderating, and that only in northern Appalachia will forecast increases in work force levels between 1985 and 1995 match historical experience. Although the actual numbers (or absolute levels) of workers will almost always be greater in the future, the report states that the forecast rates of growth for the work force (except in northern Appalachia) in the next 20 years will not equal the rapid pace of growth from 1973 to 1977.[19] (See Figure B)

Historical and Forecast Annual Rates of Coal Mine Employment Growth (percentages)

	1973-1977	1977-1985	1985-1990	1990-1995
Northern Appalachia				
Underground	6.7%	.8%	13.3%	7.1%
Surface	13.6	-3.5	-6.0	-1.9
Southern Appalachia				
Underground	7.6	1.4	-.7	.2
Surface	22.5	.5	-4.7	2.9
Interior and Gulf				
Underground	22.2	12.0	8.9	6.4
Surface	14.2	1.4	-3.4	0
West				
Underground	18.9	9.1	5.9	11.8
Surface	18.9	11.2	18.0	9.8

Source: 1973-1975 *Minerals Yearbook*; 1976-1977 Energy Data Reports, 1977-1995; John Short & Associates, Inc. Employment/Turnover Model projections.

Figure B[20]

Bechtel Energy Supply Planning Model[22]

TOTAL LABOR REQUIREMENTS (PERSON-YEAR) FOR THE OPERATION AND MAINTENANCE OF ENERGY-RELATED FACILITIES COMMERCE LIKELY U.S. ENERGY CASE

GRAND TOTAL FOR ALL REGIONS

Category	Annual Requirements					Average Growth Rates (%/Year)			
	1977 (Calc'd)	2000	1978-2000 Average	Peak	Year	1977-1980	1980-1985	1985-2000	1977-2000
Oil									
Exploration, development, & production	127,020.	64,172.	94,272.	127,020.	(1977)	-2.8	-2.0	-3.3	-2.9
Refining and processing	58,307.	42,538.	54,733.	62,005.	(1981)	1.5	-0.6	-2.2	-1.4
Pipelines	21,506.	18,634.	22,429.	24,124.	(1983)	3.5	0.1	-1.7	-0.6
Tankers, barges, trucks	84,576	64,190.	79,063.	89,488.	(1980)	1.9	-1.1	-1.8	-1.2
Bulk stations	3,830.	2,797.	3,507.	4,015.	(1981)	1.4	-1.0	-2.0	-1.4
Other	2,084.	2,037.	2,269.	2,514.	(1980)	6.5	-1.1	-1.0	-0.1
Total oil	297,322.	194,368.	256,273.	298,139.	(1979)	0.0	-1.3	-2.4	-1.8
Oil shale	0.	7,693.	4,209.	7,693.	(1994)	0.0	9999.0	5.2	9999.0
Gas									
Exploration, development & production	64,471.	45,527.	56,174.	64,471.	(1977)	-0.9	-0.9	-1.8	-1.5
Pipelines	6,166.	4,953.	5,569.	6,166.	(1977)	-1.1	-1.2	-0.8	-0.9
Lng tankers	10.	2,766.	981.	2,766.	(2000)	124.0	23.1	15.8	27.9
Distribution	122,393.	119,215.	117,977.	122,393.	(1977)	-1.0	-0.2	0.1	-0.1
Other	13.	1,344.	704.	1,344.	(2000)	58.7	17.6	17.7	22.4
Total gas	193,053.	173,804.	181,405.	193,053.	(1977)	-1.0	-0.4	-0.4	-0.5
Coal									
Underground mining	166,544.	382,612.	240,563.	382,612.	(2000)	1.6	1.7	4.8	3.7
Surface Mining	37,030.	107,124.	67,576.	107,124.	(2000)	5.0	4.6	4.7	4.8
Rail	100,780.	293,848.	176,321.	293,848.	(2000)	3.9	3.6	5.3	4.8
Pipelines	0.	3,349.	1,454.	3,349.	(2000)	9999.0	26.3	11.5	9999.0
Barges, trucks	17,902.	43,578.	28,588.	43,578.	(2000)	3.4	3.2	4.3	3.9
Total coal	322,257.	830,510.	514,501.	830,510.	(2000)	2.8	2.8	5.0	4.2
Coal synthetics	0.	10,949.	3,400.	10,949.	(2000)	0.0	9999.0	19.2	9999.0
Nuclear fuel cycle	18,242.	97,823.	60,914	97,823.	(2000)	14.3	11.6	5.0	7.6
Solar	177.	278,981.	96,500.	278,981.	(2000)	214.1	40.4	16.0	37.7
Electric utilities									
Coal-fired	37,995.	119,857.	66,900	119,857.	(2000)	3.0	2.8	6.3	5.1
Sulfur removal faciltities	669.	29,525.	15,089.	29,525.	(2000)	69.4	24.8	7.6	17.9
Nuclear	5,988.	34,649.	21,696.	34,649.	(2000)	12.4	14.6	4.9	7.9
Hydro & pumped storage	5,338.	8,097.	6,422.	8,097.	(2000)	1.6	0.8	2.2	1.8
Oil & gas	23,506.	7,638.	19,321.	24,570.	(1983)	1.2	0.0	-7.4	-4.8
Geothermal	463.	13,347.	4,519.	13,347.	(2000)	16.2	13.8	16.3	15.7
Total generation	73,958.	213,113.	133,946.	213,113.	(2000)	4.3	4.7	4.8	4.7
Transmission	1,091.	2,819.	1,916.	2,819.	(2000)	4.9	4.3	4.0	4.2
Distribution	107,302.	304,407.	194,575.	304,407.	(2000)	4.6	4.7	4.6	4.6
Total utilities	182,351.	520,339.	330,437.	520,339.	(2000)	4.5	4.7	4.7	4.7
Total energy industry	1,013,401.	2,114,460.	1,447,634.	2,114,460.	(2000)	2.0	2.4	3.8	3.2

A growth rate equal to 9999.0% implies infinite growth

Figure C

The Department of Commerce supports these figures. In a 1977 document the Department predicted that total labor requirements for the coal industry will have an annual growth rate of only 3.7 percent for underground mining and 4.7 percent for surface mining between 1977 and 2000.[21] (See Figure C) These rates can be met easily by existing training facilities and through current training programs, even taking into account the impact of recent legislation. Employment growth in the coal industry in the western section of the United States, however, is expected to increase sharply over 1975 predictions, as shown in Figure D. In absolute numbers, the greatest increase in employment will occur in the East, where over 67,000 additional miners will be needed by 1986.[23]

If 1 billion tons [of coal] are mined in 1985 and production per worker remains at current levels, approximately 100,000 new jobs overall will exist in 1985. Roughly 40,000 new hirings per year will be needed to meet this growth and replacement demand if the annual exit rate from the industry does not change.[25]

However, even though a sharp increase in the absolute number of job openings through the year 2000 is evident, the coal industry is more interested in training its own workers than it is in hiring college-trained personnel.

In addition to jobs opening up directly related to mining, the railroad industry will be increasingly important in the movement of coal from one location to another. However, most of the additional workforce required to provide these services will be manual laborers. On-the-job training predominates for these low-skilled positions. For locomotive engineers, electricians, carpenters, and masons, existing programs are expected to produce an adequate supply of workers as the programs expand in response to local demands.[26]

Regional Coal Work Force by Methods, 1975-1985

Region	1975		1985		Annual Growth (%)
Deep					
East	121,030	(89.8)	188,300	(72.2)	4.5
Central	9,150	(6.8)	19,100	(7.3)	7.6
West	4,530	(3.4)	53,200	(20.5)	27.9
Total	134,710	(100.0)	260,600	(100.0)	6.8
Surface					
East	41,450	(74.7)	41,900	(51.8)	0.1
Central	9,190	(16.6)	14,300	(17.7)	4.5
West	4,860	(8.7)	24,700	(30.5)	17.6
Total	55,500	(100.0)	80,900	(100.0)	3.8

Numbers in parentheses indicate percent of total.

Source: Joe G. Baker, "Coal Mine Training Requirements, 1975-1985," paper given at the Education, Business and Labor Affairs Conference, Washington, D.C., January 1979; and Department of Interior, *Minerals Yearbook*, various years.

Figure D[24]

Solar

While supporters of conservation and solar energy strongly suggest that great numbers of people could be employed if the country chose to adopt solar energy as a major alternative to petroleum, the National Energy Plan does not reflect the same federal enthusiasm in pursuing this energy resource as is expressed for expanding the coal industry. Coal is mentioned specifically in each of the energy plans, the Natural Energy Act, and the Energy Security Act as the long-range substitute for petroleum.

This is not to suggest that community, junior, and technical schools should not develop training programs in alternative energy fields. In fact, in every phase of energy industry growth cited in an Oak Ridge study, community colleges are mentioned as the current principal suppliers of technical and skilled workers (energy technicians, skilled construction workers, energy auditors, and many others). In addition, community colleges are singled out as probably the most likely formal trainers of the energy workforce in future endeavors.

Some researchers maintain that the solar industry, in particular, has the potential for creating thousands of new jobs. For example, a 1979 Council on Economic Priorities study of the Nassau/Suffolk region of Long Island, New York, points out that:

> Energy conservation and solar energy use in the Nassau/Suffolk region would stimulate 2.4 to 2.7 times as much employment in the U.S. economy as would use of an equivalent supply of oil, natural gas and electricity. The net effect of the Nassau/Suffolk energy conservation and solar energy strategy, after taking account of the reduced employment in the energy supply industries, would be the creation of an average of 10,000 to 13,000 jobs through the U.S. economy during the next 38 years.[27]

The jobs, however, are by and large labor intensive, involving relatively simple skills.[28]

Currently, over 600 institutions of higher education are offering solar-energy courses. Of these, 125 offer a fairly complete program.[29] The Departments of Energy, Labor, and Housing and Urban Development are also involved in solar energy training.

Installers of solar panels and systems are the most needed laborers in the solar energy field.[30] However, there is little information to establish the success of solar energy graduates in obtaining employment solely in that field. In a 1978 report on solar energy employment, only one out of every four employers thought their professional, technical, or skilled craft employees performed tasks that were substantially different from those traditionally performed in nonsolar jobs. Where new skills were identified, special solar design, analysis, and installation skills were most frequently mentioned by employers.[31]

Other job opportunities in the solar field include: carpenters, cement masons, electricians, plumbers, sheet metal workers, air conditioning technicians, heating and refrigeration technicians, glaziers, and crane operators. Also included is employment in solar engineering, architecture, law, real estate and appraisal, sales, zoning, assessment, and consumer protection.[32]

In addition, the former Federal Energy Administration listed jobs for welders, bricklayers, concrete finishers, painters, iron workers, insulation workers, electrical and mechanic engineers, technicians, scientists, and surveyors.[33]

Two educational approaches appear to be the most useful for the trainer and the worker. One is to provide supplementary training to persons already employed in a related field, such as plumbers, and teach them to install solar water and space heaters, for example. Training can be offered in the evenings or on weekends, and might be in the form of continuing education courses or certificate programs.

The other approach is to offer training as a part of a degree or certificate program. The college could offer energy options in existing curricula like heating/ventilation/air conditioning or engineering.

Few statements can be made with any certainty about employment levels in the solar energy field, but three can be made. Growth is taking place and will continue through the year 2000, but the rate of growth cannot be accurately predicted. Community, junior, and technical colleges appear to be excellent resources to train and educate the solar energy workforce.

Hydroelectric

Small-scale hydroelectric development is a relatively small job-creator when viewed in the aggregate. It has the potential, however, to severely impact local labor markets because the activity is generally centered in rural, sparsely populated communities. The major demand for labor comes in the construction phase and corresponds to the capital expenditures. Operation and maintenance requirements are very low. Currently, the Department of Labor is experimenting with a CETA program designed to train disadvantaged youths for work on hydro projects. It may provide a model for similar programs in conjunction with other hydroelectric projects.[34]

Energy Auditor

The National Energy Act appears to have created a new occupation, an energy auditor. A provision of the National Energy Conservation Act, a part of the NEA, provides that each regulated and unregulated supplier of gas and electric utilities (and most home heating oil suppliers) be required to provide inspections of residential units (not to exceed four-family units).

To accomplish the goals of the legislation, energy auditors must be knowledgeable about the use of alternative energy sources, including solar hot water heaters and devices for solar heating and air conditioning, and the use of small wind and water generators. They must also be prepared to suggest energy-saving practices and conservation measures.[35]

Staff auditors may include some fully-qualified engineers, but the bulk of the staff will probably be made up of properly trained engineering technicians. Graduates of two-year degree programs are prime candidates for these jobs.

Job-specific training, even after qualified recruits have been employed by the utility companies, will be necessary. This training might be provided by community colleges and technical schools. The utility companies may elect to do their own initial training, with some on-the-job training used as a follow-up. It is not known how many energy auditors will be needed by the utility companies, but Oak Ridge estimates that as many as 25,000 home auditors may have to be trained in job-specific programs administered by colleges, technical schools, or public utilities to keep up with the demand for residential auditors through 1985. By that time, however, there will be little need for such training since the vast majority of buildings will have been audited. Audits are seldom repeated.

Conservation

Other energy conservation positions, such as furnace retrofitters and weatherization workers, are not expected to grow appreciably. Furnace retrofitters will most likely be furnace installers and repair workers who have learned the installation procedures for energy-saving flue adapters or other devices. While considerable retrofitting activity may take place in certain areas of the country, no large-scale retraining program is likely to be needed to provide the necessary skills.[36]

Most weatherization activities, e.g., insulation, weatherstripping, caulking, storm door and window installation, etc., will be accomplished by existing and new business firms, or by homeowners themselves. Continuing education courses and one-time workshops offered by community, junior, or technical colleges could meet this training need.

Petroleum

Employment positions in oil and gas exploration may grow by 200,000, or over 50 percent by 1985. But the training is of a highly technical nature and most often would require a degree beyond the two-year level. For other positions in the petroleum industry—refining and processing, pipelines, tankers, barges and trucks, bulk station operation—the employment rate is expected to drop as well. (See Figure B) According to one report from a major petroleum industry trainer, many workers

trained in Alaska are being forced to seek employment in Texas, for example.

Substantial increases in manpower demands are expected in the oil shale industry in which petroleum is extracted from kerogen contained in sedimentary rocks. With the recent passage of the Energy Security Act, the industry should begin expanding immediately and continue for a long period of time. Workers and technicians with skills in the production technology, environmental safety systems, and the operation of new equipment for mining and transporting the new synfuels will be needed in the future in states like Utah, Colorado, New Mexico, and Wyoming where these energy sources are found. Other technicians and skilled workers will be needed in the states through which new pipelines or other transportation systems will pass as the fuels move to reach population centers.[37]

Nuclear

The nuclear industry is currently experiencing a significant slowdown in growth. Its future is uncertain, and only a very moderate overall employment growth is expected. Both the Atomic Industrial Forum and the Edison Electric Institute report that they will make no attempt to predict future employment in the nuclear industry because of the uncertainty of it. Some of the reasons for this situation can be found in the statement below:

> . . . Questions about public health and safety have received a great deal of attention since the accident at the Three Mile Island facility. In addition, concern about environmental effects, unresolved issues and policies for waste disposal and reprocessing, actual and proposed state and federal moratoriums on new nuclear power plant construction and operations, reductions in export sales because of concern about nuclear weapons proliferation and because of increased foreign competition, rapidly increasing construction costs, changes in required power plant design and engineering, and a reduction in forecast[ed] growth in electricity requirements all contribute to the present uncertainties and reduce the growth in the nuclear energy field.[38]

Currently, 10 to 12 nuclear power plants are scheduled to go "on line" this year, and 50 are scheduled to open between 1981 and 1986.[39] One national authority has indicated that although the 1980 schedule might not be met, no obstacle to the opening of the 50 facilities by 1986 is foreseen since all federal moratoriums on the planning and construction of nuclear power facilities have been lifted.

Some growth is predicted in certain areas. Moderate expansion is expected in the nuclear fuel cycle, mining and milling area of the industry, and rapid growth is predicted in the power plant operation and maintenance area. Only slow growth is expected in the fuel conversion and enrichment portion of the industry, however, and no growth at all is predicted in the fuel fabrication, waste disposal, reprocessing, transportation, special materials production, and design areas, or in nuclear-related research and development facilities. In fact, the latter will probably decline. (See Figure E)

While community, junior, and technical colleges can meet some of the training needs of the nuclear industry, it is certain that the industry will not be expanding rapidly enough to employ great numbers of people. (See Figure F)

Biomass, Wind, and Geothermal

Biomass is considered a part of solar technology because of the use of the sun in the energy conversion process. However, for purposes here it has been separated from solar.

Through biomass conversion, fuels may be produced from crops such as corn, or from municipal or animal wastes. Gasohol, a combination of ethyl alcohol and gasoline, is already

Summary—Near-Term Employment Trends/Expectations for Selected Segments of the Nuclear-Related Field

Segment	Near-Term Employment Expectation	Remarks
Nuclear fuel cycle Mining and milling	Moderate growth	Some reduction in activity expansion announced. Relatively few scientists, engineers and technicians. Most activity located in mountain states in the West.
Fuel conversion and enrichment	Slow growth	95 percent of employment in contractor-operated facilities, most of which is in 3 enrichment plants.
Fuel fabrication, waste disposal, reprocessing, transportation, special materials production	Probably no growth	Little employment growth in the mid-1970s. Almost 50 percent of employment in contractor-operated facilities. Many unresolved issues with respect to waste disposal. No reprocessing permitted at present for electric power plant waste. Employment in private sector fuel fabrication decreased in mid-1970s.
Power plant operation and maintenance	Rapid growth	Even after slowdowns and postponements, latest estimates indicate number of nuclear power plants in operation will double by 1986 or 1987.
Reactor design and manufacture	No growth at best, probably significant reductions	Evidence indicates some employment decline at present. Large numbers of engineers and technicians work in this segment.
Design of nuclear facilities	Slow growth at best, possibility of some decline	Difficult segment to review. Employs large numbers of engineers and scientists.
Nuclear-related R&D facilities	Little or no growth, very possible to have actual decline	75 percent of employment in contractor-operated facilities. President's proposed budget calls for funding decrease for nuclear energy R&D. 50 percent of all scientists in nuclear-related field in this segment plus large numbers of engineers and technicians.

Figure E[40]

Job Classifications Within Nuclear Power Plants, Technician and Skilled Workers

Job Group	Percent	Job Group	Percent
Reactor operations		Stores	
Licensed (senior and operator)	10.7	Journeyman storekeeper	0.9
Unlicensed		Helper storekeeper	2.2
Journeyman	4.1	Administration	
Helper and trainee	20.7	Senior and journeyman clerk	0.3
Maintenance electrician		Clerk helper	4.3
Senior and journeyman	6.5	Not reported	0.1
Helper and apprentice	1.8	Total	100.00
Maintenance Mechanic			
Senior and journeyman	14.0		
Helper and apprentice	7.1		
Maintenance, other			
Nonstandard craft and janitor	4.5		
Instrument and control			
Senior and journeyman	8.9		
Helper and apprentice	4.7		
Health physics technician			
Senior and journeyman	7.6		
Helper	1.6		

Source: The data were collected in the latter half of 1977 by the International Brotherhood of Electrical Workers (IBEW) in a survey of union locals in nuclear power plants. At the time of the survey, the IBEW represented approximately 60 percent of the United States nuclear power plants. Survey results were received from 1,804 workers in 30 of the 39 power stations represented by the IBEW. This is approximately a 60-percent response for the 30 stations that co-operated with the survey.

Figure F[41]

being sold by gasoline stations across the country. National experts anticipate that ethyl alcohol will one day become a cheap substitute for the gasoline we have been using in automobiles.

The development of this fuel will have a substantial impact on rural areas where workers involved in production and distribution will be needed.[42] Yet, alcohol fuel production is a capital intensive enterprise. Few technicians will be needed to satisfy manpower demands, but many low-skill jobs may be created. Because the industry is in its infancy, however, it is impossible to predict future employment needs.

Geothermal energy is based in the use of hot water found below the earth's surface. One famous geothermal landmark is "Old Faithful." Proponents of geothermal energy use say that it is economically feasible because it is conducive to low capital enterprises which can create many jobs. The generation of electricity through wind power is also thought by some to be

currently economically competitive with other systems, at least on the seacoast of the northeastern states.[43]

Jobs in the wind, geothermal, and biomass conversion energy industries may develop. They will be few in number, geographically confined, and concentrated in small companies. The more immediate jobs will be in research and development. Technicians, craftsmen, and service personnel will come from traditional training disciplines and not from specialized ones.[44]

Construction Industry

The construction industry is not directly related to energy, but will contribute significantly to the growth of alternative energy usage in this country over the next 20 years. Labor force studies suggest a growth in energy construction employment from the 1975 level of 284,500 workers to 486,220 in 1985.[45]

One resource states that critical shortages may develop in some job areas, e.g., electricians, pipefitters, boilermakers, welders, and carpenters. Without workers skilled in energy-related construction, large energy projects may not flourish.[46]

Community, junior, and technical schools have long been in the forefront of the training of these workers. By adding energy options to existing curricula, these industries may quickly provide for the anticipated growth in this area. One resource notes, however, that union apprenticeship programs will be the major supply source for skilled building trades craftsmen. Graduates of vocational school construction trades programs will be a source of employment for non-union contractors.[47]

Summary

Figure G offers a review of the anticipated employment in solar, coal, energy conservation, construction and some other areas mentioned here, and includes education and training implications. The details represent gross national projections.

The training the colleges offer must be responsive to the needs of local business/industry, both current and anticipated. If, in their enthusiasm to respond to national and local problems (like the energy crisis), the colleges introduce training programs for which there is no clear job market for graduates, a number of negative results are possible, such as: student disenchantment with education and the college, student disenchantment with the workworld and the possibility of interesting employment, and lost credibility of the college in the community.

Another important negative result could be the relocation of graduates to areas where jobs exist. Oak Ridge and others point out that employment and technician needs will vary widely by region, underscoring the importance for institutions to assess carefully labor demands in their own areas. The loss of trained skilled and semi-skilled workers can diminish community vitality and economic health, reduce possibilities of attracting new business/industry, and discourage the expansion of those businesses/industries that currently exist. Under such circumstances, no one benefits.

To avoid these negative consequences, colleges must examine national energy problems as they are translated locally.

A literature review of potential employment in the energy industry reveals few precise directions for educational institutions to follow. Some writers suggest that there will be a "boom" in the solar industry, for example, and others say this will not happen. Some project that with increased national emphasis on coal usage, the industry will expand rapidly and the need for trained personnel will expand also. Others say that there are enough programs in place today to meet coal industry demand through the year 2000.

The only certainty is that change is taking place. As a way of defining the nature and dimensions of local energy management needs, Department of Energy officials, two-year college faculty and administrators conducting energy programs, and others strongly emphasize that a manpower needs assessment be conducted prior to the implementation of an energy curriculum.

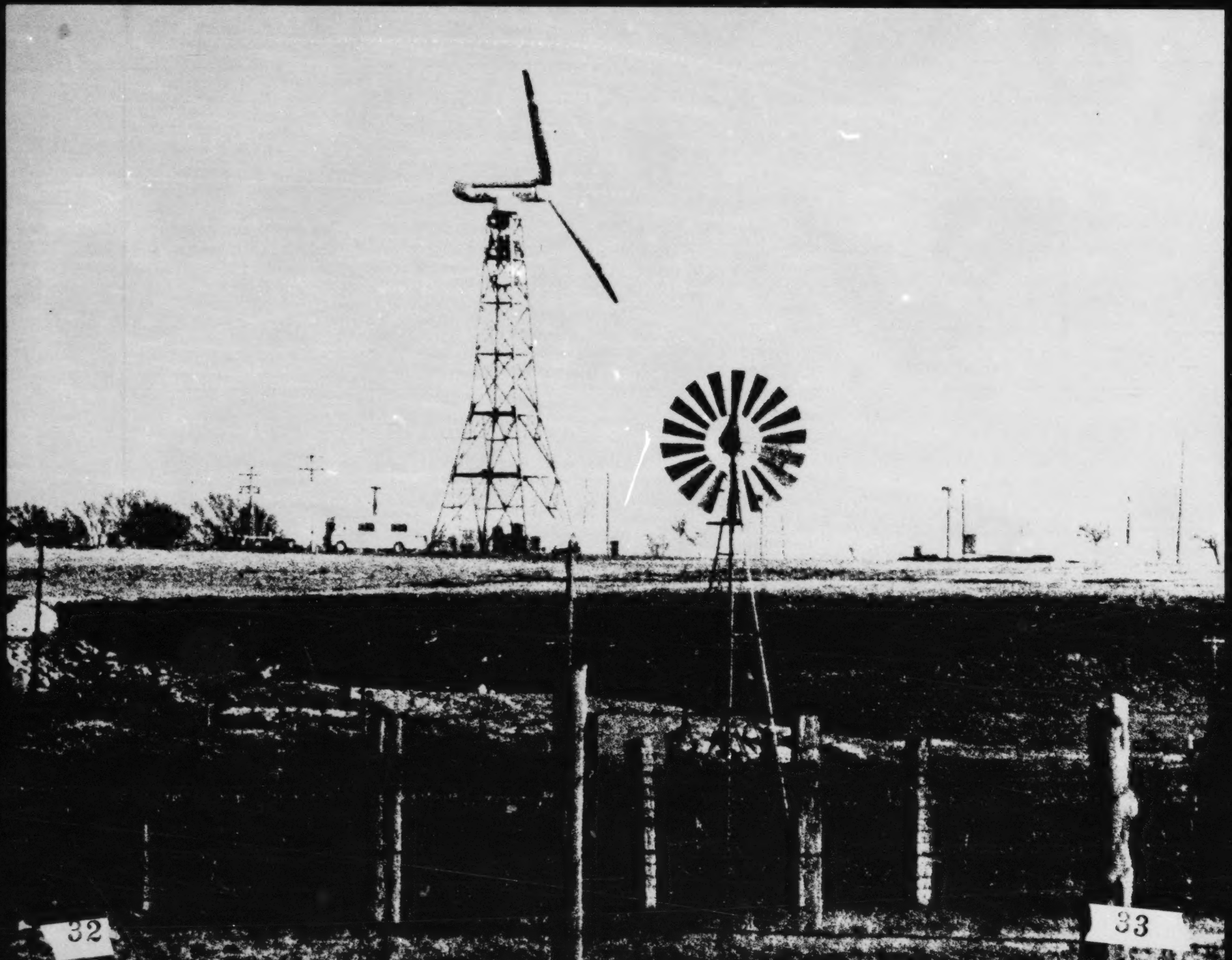
Summary of Major Employment, Education, and Training Impacts of NEA by Type of Activity		
Type of Activity	**Anticipated Employment Impacts**	**Education and Training Implications**
1. Construction of Energy Facilities	Predictions range as high as 5.5 percent annual growth in employment for construction of energy-related facilities	Training of boilermakers, pipefitters, welders, and electricians is important to meet demand. Construction and chemical engineers will also be needed in large numbers. Engineer technicians are expected to be used in increasing numbers on energy projects
2. Coal Conversion	a. 100,000 additional miners may be needed by 1985, with 68 percent of the growth in the East	To accommodate growth, 40,000-50,000 new miners may have to be given skill and safety training each year
	b. 55,000 additional railroad workers may be needed to transport coal	On-the-job training will provide skills needed for most new rail transportation jobs
	c. 40,000-50,000 additional workers may be needed in related activities such as rail car production and mine construction	Impacts will be felt in mining engineering programs and appropriate apprenticeship programs
3. Energy Conservation	a. As many as 8,600 auditors and 500 inspectors may be needed for residential audits each year through 1985	As many as 25,000 home auditors may have to be trained in job-specific programs administered by colleges, technical schools, or public utilities
	b. More than 6,000 additional workers may be needed by 1985 to make energy-saving furnace modifications	On-the-job training will be required for personnel to conduct furnace modifications
	c. Weatherization workers for weatherstripping, caulking, storm window and door installation, etc.	On-the-job training by existing firms and CETA training for weatherization of houses of low-income families

Figure G[48] (continued on next page)

Type of Activity	Anticipated Employment Impacts	Education and Training Implications
4. Solar Energy	Uncertain employment growth in design, manufacture, installation, operation and maintenance of flatplate collectors, photovoltaics, gasohol distilleries, wood boilers, etc.	Unpredictable employment growth and recent proliferation of solar-related education programs leave further developments in this area uncertain
5. Other	a. Oil and gas exploration employment may grow by 200,000 or over 50 percent, by 1985 b. Entry-level employment of nuclear engineers and technicians is uncertain c. Research and development activities are expected to grow in most energy areas. Coal and other conventional fuels production will share growth with synthetic fuels, solar, and other unconventional energy source research and development activities	Training of geologists, geophysicists, and extraction technicians will be needed Training and education requirements for nuclear-related jobs are very uncertain Education in traditional disciplines with an emphasis on energy-related issues will provide necessary research and development personnel

Figure G[48]

Community colleges should view themselves as local assets for economic development. They are logical centers to train skilled and semi-skilled technicians for local businesses or industries. They can play an important role in attracting additional business and industry to the area.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4 The Role of Community, Junior, and Technical Colleges in Energy Education

No type of postsecondary institution is more appropriate for addressing energy education needs in this country. In addition to the colleges' easy access policies and their low costs, the community-specific character of the institutions makes them invaluable resources not only for responding to local energy education needs but also for translating and implementing national initiatives endemically.

Energy education is not an issue that colleges can approach passively. The effects of energy costs and shortages (especially liquid fuels upon which 17 percent of all postsecondary institutions rely directly) burden community residents as well as the colleges. At a time when college operating budgets are being held steady or are decreasing (in real dollars), the impact of energy problems makes the issues of vital concern. The concerns are not simply theoretical, they are practical.

In the last several years, colleges have engaged the issues aggressively. Their approach has taken several forms: facilities conservation, general public information, short-term specialized instruction, courses and sequences of courses, and certificate and degree programs.

Institutions have developed and applied carefully-thought-out plans for retrofitting existing buildings, for conserving energy use without significant changes in operations and scheduling, and for building in conservation features in new facilities. Several colleges have received national acclaim for their efforts and serve as national models for all postsecondary institutions to emulate. Some of the more creative institutions are combining facilities conservation measures with classroom instruction by using the college facilities as a laboratory for students enrolled in energy-related curricula. Institutions have added alternative, renewable energy sources to their power plants as a way of supplementing traditional sources and of reducing reliance on power companies. Wind generators, geothermal wells, solar collectors, photovoltaics, wood burning boilers, and alcohol columns are examples of these supplementary energy sources. Some institutions are creating comprehensive, integrated energy systems both as a means of demonstrating (particularly for local farmers) the possibilities of small-scale energy self-reliance and for applied research purposes. While some of these efforts are supported by state and/or federal funding, much of the work is financed by the college, sometimes with contributions from local business and industry.

The colleges are playing an active role in presenting opportunities to the general public to help shape intelligent individual and collective energy decisions. For example, more than 450 colleges participated in the national program, "Energy and the Way We Live: A Public Issues Forum," administered by AACJC and funded by the National Endowment for the Humanities, state humanities councils, the U.S. Department of Energy, and others. The central purposes of the forums included: sharing a diversity of expert opinion on central energy

questions, permitting community residents to express their positions and concerns regarding energy matters, displacing the myths and emotionalism that frequently discourage rational energy decision-making, and providing guidance to local communities regarding what they might do to solve their energy problems. As an unintended outcome, many of the colleges were able to gauge community interest in additional energy programming.

Another example of the public information role colleges can assume is the establishment of energy resource centers. While most of these centers are in early stages of development, the potential benefits to the community are great. The centers are providing a variety of energy services. Some have produced brief audiotapes on a number of energy topics that can be accessed through the telephone. Others are establishing comprehensive libraries of textual materials, media, self-instructional programs, bibliographies, and lists of consultants and commercial manufacturing firms in the area. On-site technical assistance is also made available. The centers also offer special training programs of interest and use to community groups of various sorts.

The greatest percentage of those colleges offering energy education programs of any sort are offering them through community services and continuing education departments. The courses, seminars, and workshops cover a variety of energy topics, but generally they focus on a specific energy resource form. Short term, practical, non-credit programs are offered in solar, greenhouses, wind generators, weatherization, audits, and alcohol fuels. Related courses include interpreting energy bills, auto maintenance, and home gardening. Colleges are taking these initiatives to provide information and skills useful to residents and to gauge the strength of interest in any one of the areas. With an adequate interest level and clear evidence that there is a labor market demand for specially trained technicians, the colleges can build upon modest beginnings.

Stimulated by the foresight that technicians in energy-related occupations should be familiar with energy theory and equipment, many colleges have introduced energy courses in standing curricula. Mechanical engineering, agriculture, heating/ventilation/air conditioning, building construction, architecture, plumbing, and sheet metal are some of the curricula into which energy courses have been introduced. More theoretical, philosophical, and social concerns generated by national energy problems have been introduced into humanities programs in some colleges. Most of these concerns have been offered as units or modules in a single course.

Based on AACJC's latest count (1979), approximately 40 colleges are offering energy-related degree programs, ranging through solar technology, alternative energy, energy management, nuclear technology, petroleum/mining technology, and energy audits. Eight certificate programs were identified also. These details were produced by a limited survey, so the number of degree and certificate programs is most likely greater than the numbers reported here. Many institutions offer both the degree and certificate for their programs. As national energy trends become clearer, as labor market demand for energy technicians is clarified, and as more institutions apply local needs assessments, the total degree and certificate curricula presented through the colleges will expand. At this point (and as they should) colleges are approaching the introduction of new energy curricula with caution. The cost of the programs is not the only reason for the caution. The colleges are in the business of satisfying local educational needs. If there is not clear evidence that energy technicians are in demand in the colleges' service district, programs to train technicians are not introduced.

There is an exception to this position. Colleges can serve as state, regional, or even national training centers for energy technicians. If a college has special interests, experience, and skills, the state department responsible for community colleges

may select that college to introduce a certificate or degree program for which there are only minimal employment opportunities for graduates in the college's service district. For the purposes of such a state program, a college might agree with other colleges that it would be the special training center for an energy technology, thus providing technicians across the state, negating the need for other institutions to introduce the program.

On the regional and national levels, the issues become a little more complicated. Such a program can leave the impression that while a national service is being provided, public revenues, facilities, expertise, and community youth are being transported to other communities across the country. The practical benefits to the community may be hard to identify. In spite of the disadvantages, however, and in light of the uncertainty concerning the numbers of technicians that are now or might be in demand in emerging energy occupations, particularly in renewable energy production, some colleges may wish to serve as the technician training center for an area wider than its own service district.

The energy education activities that colleges have undertaken are sundry. The likelihood is that these activities will multiply in the near future. Although the history of college involvement in energy education is relatively brief, their experiences have been substantial. The experiences of already-involved colleges are valuable resources that should be tapped by those institutions just beginning to introduce programs and those minimally involved.

5 Program Components

The ideas and issues presented in this section are in large part the result of a telephone survey of energy program directors in 13 community/junior/technical colleges across the country. While the survey instrument shaped the discussion, the program directors were encouraged to raise other issues that were significant in the operation of their activities. Thus, while none of the topics are described definitively, the ones identified are those that have arisen out of practical experience and are, therefore, central to the development and administration of new and/or expanded energy programs in colleges.

Program Development: Logical First Steps—Before beginning any curriculum on a campus, administrators and faculty should assess the need for the curriculum. Exploring the idea with local industry, business leaders, union representatives, and the general public will result in a curriculum design that meets the needs of the local population the college serves. Needs assessment also protects colleges from hastily entering into a curriculum that may not be realistic, both in terms of community interest and local labor market demand. The results of a well conceived and structured needs assessment will show the institution how to proceed, or whether to proceed at all.

Most institutions start small when they do decide to approach a new curriculum. Beginning offerings are frequently introduced through the continuing education department. This allows the faculty and administrators to mold the coursework to meet the needs of their constituencies, and to eliminate unwanted or low demand topics from the curriculum. Workshops, seminars, courses—either for credit or no credit—are ways of introducing new ideas and materials into the general curriculum of the college and to the public. As the interest level grows in a particular energy area, college officials will be able to discern more easily those areas that could support a degree or certificate program, as well as existing programs in which the coursework might be incorporated. On the other hand, colleges may not want to proceed further than workshops, seminars, and individual courses.

By proceeding cautiously, colleges can measure the level of student and community interest or need by the responses to their offerings. The colleges can respond to the interest and needs without having used valuable resources that might best be spent in a different program.

When there is evidence that community interest and the employment market warrant a full-fledged curriculum, major parts of such a program can most often be created from standard offerings. In large measure skills requirements in energy occupations are not so unique that an entire new curriculum has to be designed. Existing offerings can be re-focused or new modules added to them to satisfy the special needs of a new technician training effort. For example, courses in heating/venti-

lation/air conditioning can fit neatly into a solar technician program with some modest re-focusing. Plumbing, sheetmetal, and home construction curriculums can also be reshaped for this purpose.

In a 1980 AACJC/National Gasohol Commission-sponsored Alcohol Fuels Seminar, college faculty interested in alcohol fuels technology programs agreed that about three-fourths of the courses needed for such a program were already being offered in most colleges. Two to three additional, special courses would have to be added to complete the program. While standard lab equipment could be used to demonstrate distillation, for example, a full-scale still is an integral part of any alcohol fuel program.

As a result of this sort of restructuring, little additional expense to the college would be necesary to conduct a program in alcohol fuels production technology.

Faculty: Identification and Development—Locating and hiring competent faculty is a severe problem for colleges offering specialized energy programs. Chiefly, colleges find it difficult to compete with salaries offered in private industry. Colleges have to rely on dedication to hold faculty in these courses.

Most colleges draw instructors from three pools: trained educators, industrial professionals, and technicians. Many combine all three on their energy program faculties. Often, technicians are better for certain types of coursework (plumbers, pipefitters, etc.) than trained educators because of their direct, hands-on experience and because of their current contact with local firms related to the coursework. The mix and balance changes from curriculum to curriculum, as does the approach by each college in presenting that curriculum.

Because the knowledge needed to teach energy programs is changing rapidly, it is important that colleges provide for staff and faculty development. This may take the form of sabbaticals, administrative leave, summer seminars, or workshops. Some colleges encourage their faculty to attend conferences and workshops during the year by allowing them the time to attend and paying for their travel and expenses. Other colleges offer training on their campuses, often in cooperation with area colleges and universities.

Field practitioners reported that what would be particularly helpful to them is release time during the school term—or summer compensation—for research and writing. They noted that this time could be used effectively to write needed texts, and to update the information they teach.

Facilities and Equipment—All colleges must provide classrooms for instruction, no matter what the curriculum. Most of the surveyed colleges indicated that laboratory work of some type was needed to complete their curriculum, regardless of the energy field. The type of energy program being taught, i.e., solar, mining, petroleum, dictated the type of equipment needs. All of the energy program administrators who responded stated that without the assistance of industry, they would have been unable to provide the needed equipment to train in their particular energy field.

For example, industry provided computers, diesel motors, complete petroleum equipment (simulated), an alcohol fuels plant, and a power boat used in a conservation course. All colleges noted, however, that a number of their equipment needs were met through state funding.

One college in Florida that teaches an energy conservation curriculum turned the entire campus into a laboratory. Students in the energy curriculum, all of whom come to the college with either a degree in heating/ventilation/air conditioning or an equivalent degree or experience, audit all campus buildings, take measurements, and perform all necessary retrofitting. The campus reported a 30 percent reduction in its own energy consumption in the first year.

The use of mini-computers was mentioned by several practitioners. Hand-held calculators are used extensively, and some colleges use small computers to simulate equipment they do

not have and situations students might face working with the actual equipment. Their value is limited, however, even though their use is increasing. One practitioner suggested that simulations through the use of computers are "practically useless," and that scaled down models of necessary equipment are better substitutes.

However, mini-computers can be very effective in energy management courses when necessary calculations may number in the thousands. Each energy program dictates the kind and extent of use mini-computers might have.

Advisory Committee—Community, junior, and technical colleges are unique in that they have seldom approached a degree program without the assistance of an advisory committee. Such a committee usually continues throughout the life of the program.

The usual role of the advisory committee is to advise the faculty and staff of changes in the field that should affect the curriculum, suggest changes in the curriculum to strengthen it, help identify individuals who might serve as faculty for special topics, and provide the college with a "trained eye" to review the needs of both industry and the students. Additionally, a committee may serve as a vehicle for program legitimation and, in fact, through such a function encourage others in the community to recognize the importance of and need for graduates. Sometimes programs have to be sold to employers who might reasonably be expected to hire the graduates. Advisory committees can help in the selling process. In some instances, advisory committee members assist in student placement and, in fact, hire graduates themselves.

Advisory committees are most often small, not more than ten or twelve persons. They are drawn from several areas: industry, education, labor unions, technical professions, business, state governing boards, and the community. They are knowledgeable about the curriculum content.

For example, a solar energy degree program in a two-year college in California has construction personnel, trade contractors, union representatives, and educators on its committee. A mining program in Virginia has miners, representatives of the personnel offices of local mines, reclamation engineers, mine owners, unionists, and state education representatives.

Although advisory committees often meet infrequently—from once a quarter or semester to once a year—they are an integral part of the degree curriculum.

Student Admissions, Guidance, Counseling, Placement, and Follow-Up—Most community, junior, and technical colleges have minimal or open admissions policies. Some of the technical energy programs, such as engineering, require certain skills to complete the courses successfully. While no students were turned away from the programs offered in the 13 colleges surveyed, some were placed in skill building courses (mathematics, science, English) to improve their competency in certain areas before proceeding into the regular coursework of that curriculum.

Guidance and counseling services are offered at all community, junior, and technical colleges. Most have formal centers where students may come for assistance, and others offer career guidance and counseling as a part of the curriculum. Persons employed in the field the students are studying are brought into the classroom or laboratory to talk to students, demonstrate certain techniques to them, or answer questions students may have about the actual working conditions they will face if they pursue a career in the particular field in which they are training. For others, internships or practicums—often for credit—are a part of the regular coursework, allowing students to experience first-hand the demands of the job.

Institutions may have formal placement offices that try to match students with available jobs, and some have formal agreements with industries or businesses in their locales to hire a certain

percentage of the graduates of a particular curriculum. Other institutions have no placement program.

Follow-up activities (finding out how many students were placed in the field for which they trained and how successful they have been in terms of staying on the job) are seldom conducted by the colleges interviewed by telephone. Most of the college personnel indicated that they did not have the staff time to do this. Follow-up can be an important indicator of whether or not training is meeting the needs of business and industry, as well as the needs of the students who have completed the program. It is another tool for strengthening and broadening programs.

Outreach—While some colleges indicated that they did little or no student outreach (some reported that their programs were so popular that they had to turn students away), most of the colleges used similar outreach approaches for energy programming. Local media (TV, radio, newspapers) were used to make course announcements. Some colleges developed their own public service announcements (PSA's) for local radio and television stations, and others developed and published special interest stories on successful graduates or students in energy courses.

Posters, fliers, brochures, and catalogs were placed in areas where prospective students were most likely to see them. A number of colleges posted course announcements on the bulletin boards of local industries and businesses to attract workers already employed but who might want to supplement their knowledge.

Almost all colleges participate in "College Nights" at local high schools, recruiting high school students soon to graduate. One college offered a mini-seminar on conservation at a local campsite.

Outreach should not be limited to publicizing the college's energy programs, however. Colleges can work cooperatively with other institutions. Two examples of outreach are in-service training for area high school teachers and joint community/junior-vocational training college programs.

It is logical that high school students who will pursue energy or energy-related careers will need some background prior to entering college. Mathematics and science are particularly important in energy curriculums, and a foundation can be laid while in high school. High school teachers need to be taught about energy, too, so that they can include necessary preparatory information in their lesson plans. The colleges can offer in-service training to high school teachers either at the schools or on campus, and a cooperative agreement can be worked out between the school district and the college.

Of particular interest at the postsecondary level is the integration of community/junior college programs with vocational/technical programs. As mentioned before, persons training in heating/air conditioning/ventilation work in technical schools may only need supplementary training to retrofit furnaces, for example. The building and construction trades coursework may need supplementary instruction in the installation of thermal windowpanes and solar panels to qualify graduates as energy "technicians" in these areas. Cooperative arrangements between the two types of institutions is natural. One institution can perform the classroom training, and the other can offer lab and apprenticeship/internship training.

Cooperation is easiest to achieve if the courses are non-credit. The schools can issue joint certificates upon completion of the programs, and both the schools and the students benefit from the different offerings of each institution. When credit is awarded, however, the situation can become complicated. State departments responsible for community/junior college credits, and departments responsible for vocational/technical credits, often have different standards. A particularly thorny problem is the different faculty credentials required. Degreed faculty are generally required at community/junior colleges, but they do not have the necessary industrial background to teach

at vocational/technical colleges, and vice versa. The arrangement, then, is probably easiest to achieve if based on non-credit status.

Program Evaluation and Revision—Program evaluation is particularly important in energy programming since the field is in such a state of flux. National initiatives are changing from year to year. The changes have a strong influence on labor market needs and on the emergence of new employment opportunities. Stimulated by national concerns, the results of research in various energy areas are being published frequently. The findings require translation for use in college classrooms and the expansion and/or alteration of curricula to ensure that students are trained in the latest technology.

Periodically, most institutions evaluate and review their programs to see if they are meeting the needs of the students and the employers. A formal evaluation instrument is often developed to test out the program, and includes many of the items discussed previously: placement, success of students, positive attitudes of students and employers, and others.

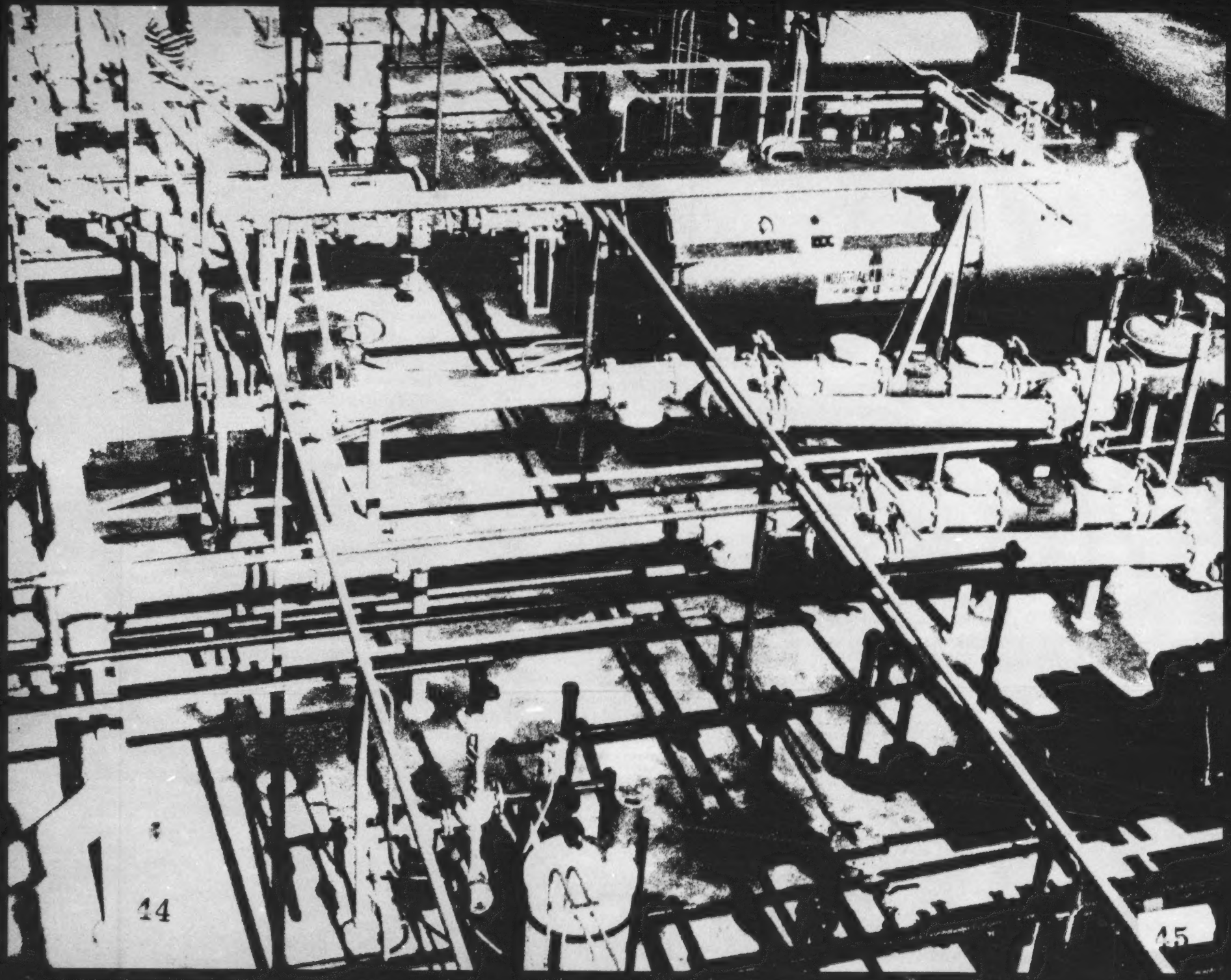
Articulation—Many of the energy programs, such as solar installation, mining, alcohol fuels, and retrofitting, do not lead to a four-year degree. Others, like petroleum engineering or other engineering associate degree programs, naturally form the basis for a four-year degree program. Most of the colleges offering this type of basic program have arranged with nearby or in-state colleges for the transfer of credits from the two-year institution to the four-year college.

Major Problems—There are always problems in instituting and operating a curriculum. Some are on-going, some are one-time, some appear, disappear, and then reappear much later in the life of the program. Some common problems were identified by the energy program administrators.

The first was money. Money for staff and faculty, equipment and facilities was never adequate, but most of those who spoke about it were philosophical. It's a given. One point that was made over and over, however, was that federal funding is often difficult for colleges to use effectively because it is generally only for a year, and therefore fragments the efforts of the colleges. If it were for a longer period, the colleges would have more planning and utilization time. As it is, they barely get started before it is time to close out the project.

Faculty staffing is another major problem for colleges. Some of the fields now being taught (solar and geothermal, for example) are so new that there are few faculty members available to teach them. And, as mentioned before, those who do teach are enticed by industries that can offer better salaries than the two-year colleges.

Another major problem encountered is a lack of well-written, thorough texts. Material content is changing so rapidly that texts are often out of date by the time the college opens the classroom door, *or*, there is no material on a given topic. Alcohol fuel production is a good example of an area in which there is great college interest but no prepared curriculum that meets the teaching needs.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6 Program Funding

Possible funding sources helpful in developing and implementing energy curricula at postsecondary institutions can be found in either the federal or state public sectors, or through private sources such as foundations, utility companies, or business and industry. Most state monies actually emanate from the federal government through revenue sharing programs.

Very few resources are directed specifically toward energy programs. Many general programs can accommodate energy education, but it is the responsibility of the colleges to meld energy with the general funding interests of the public agencies or private sources offering assistance.

CETA, for example, is not specifically geared toward energy; however, it may be a useful resource. Cooperative arrangements among colleges, CETA prime sponsors, and other nonprofit community organizations can successfully combine energy-oriented job training with education.

Many foundations have broad interests that would easily encompass energy-related proposals. Some, like the Geraldine R. Dodge Foundation and the Exxon U.S.A. Foundation, have a specific interest in the energy field.

Geographic considerations must also be taken into account by institutions seeking funding in the private sector. Foundations, business and industry, and utilities very often fund only those programs located within certain geographical limits. Generally, corporate entities only fund institutions that serve communities in which they have corporate facilities, and utility companies act similarly.

The two most useful resources at the state level are the State Energy Office and the State Department of Education, Community College Division. Each of the states has energy and education departments.

A number of published texts offer information on funding sources. A selection of funding guides of use to college faculty and administrators who are seeking resources for energy programs is outlined below. A brief description of the material contained in each is included also.

1. "Comprehensive Program & Plan for Federal Energy Education, Extension & Information Activities," Third Report to Congress, by the Department of Energy, March 1980. The 63-page report includes information on and analysis of the role and development of federal energy outreach activities, as well as an outline of the 1980 management plan for energy programs. Appendix A provides a detailed outline of the outreach activities of 13 federal agencies, including program objectives, an overall description of each, target audiences, delivery mechanisms, budget appropriations, and the name, address, and telephone number of a contact person for each of the 80 programs listed. Grant programs, material and equipment dissemination, and training programs for students and faculty are described. Available from: National Technical Information Services, U.S. Department of Commerce, 5285 Port Royal Road,

Springfield, VA 22161; DOE/CS-0151; $11.00/printed copy; $3.00/microfiche.

2. *Energy Resource Guide,* by the National Council for Resource Development, an affiliate of the American Association of Community and Junior Colleges, June 1980. The *Guide* identifies 140 discrete funding sources which could be used to support college energy-related programs. The references include addresses, telephone numbers, contact persons, funding levels, and program interests for each of the organizations/offices. Of the total entries, 39 federal offices are described, 23 state/regional, 47 corporations/utilities, and 31 private foundations. The appendices include reference lists of state alcohol fuels contacts, DOE regional education representatives, and state energy extension offices, among others. The 176-page text is available from: NCRD Energy Project, AACJC, One Dupont Circle, N.W., Suite 410, Washington, D.C. 20036; $3.00.

3. *Sources of Fund$ for Solar Activities,* by Anita Gunn, 1979. Section I discusses foundation funding, including a guide to "getting in the door," and putting together a proposal. The source-book lists representatives of 38 foundations with solar/alternative energy interests, including names, addresses, and telephone numbers of contact persons, past funding activities and grant limitations. Section II reviews sources of funds available in 14 federal agencies or departments. It includes a review of each program listed and the contact office and telephone number. Section III discusses model state funding programs in nine states. Contact persons, addresses, and telephone numbers are included with the descriptions of each program. The appendices include the names and addresses of regional offices of the federal agencies described in Section II, information on the Foundation Center, and a fundraising bibliography. The sourcebook is available from: Center for Renewable Resources, 1001 Connecticut Avenue, N.W., 5th Floor, Washington, D.C. 20036; $7.99 (includes postage & handling), 121 pp.

4. *Bio-Energy Directory,* by Paul F. Bente, Editor, April 1980. Reports on more than 650 significant activities in 34 countries in the area of biomass resources, microbial and thermal conversion, and offers general appraisals. Each program is listed separately by project name, location, objective, contact person and address, current status, and general descriptive information, including funding source. The 768-page directory is available from: The Bio-Energy Council, Suite 825A, 1625 Eye Street, N.W., Washington, D.C. 20006; $70.00.

5. "A Selection Guide to Federal Energy and Education Assistance," published by the U.S. Department of Education, 1979. Offers a brief guide to programs, not necessarily related directly to energy, but which may be adaptable. For the eight federal departments or agencies listed, the guide includes program title, purpose, types of assistance available, authorizing legislation, FY 1979 funding level, an outline of qualified applicants, and the names, addresses, and telephone numbers of contact persons. Free copies are available from: Energy and Education Action Center, Department of Education, Reporters Building, 400 Maryland Avenue, S.W., Room 514, Washington, D.C. 20202; 23 pp.

6. *Compendium of Federal Programs Related to Community Energy Conservation,* by Department of Housing and Urban Development, February 1979. The *Compendium* lists a range of federal resources which community groups, including higher education institutions, can draw upon to implement local energy conservation techniques with federal resources. Most of the programs are administered through state, county, municipal and local public and private agencies. The *Compendium* is divided into the following areas: Information and Intervention; Housing Weatherization, Repair, and Rehabilitation; Non-Housing Assistance; Consumer Protection; Solar Energy; and Appropriate Technology. It includes a description of each program, the administering agency or department, eligibility requirements, and intended benefits to participants. Free copies are available from: NVACP Energy Conservation Staff, Room 3174, U.S. Department of Housing and Urban Development, The HUD Building, Washington, D.C. 20410; 59 pp.

Appendices

Footnotes

1. Stobaugh, Robert, and Yergin, Daniel, Editors, *Energy Future*, Report of the Energy Project at the Harvard Business School, New York, New York, 1979, pp. 58-59.
2. *Ibid.*, p. 59.
3. *Ibid.*, p. 52.
4. *Ibid.*, p. 17.
5. *Ibid.*
6. *Ibid.*
7. *Ibid.*, p. 18.
8. Executive Office of the President, Energy Policy and Planning, "The National Energy Plan," Washington, D.C., April 1977, p. vii.
9. Executive Office of the President, *op. cit.*, p. 18.
10. *Ibid.*
11. White House Press Office, "National Energy Policy—Background Report," July 1, 1980.
12. White House Press Office, *op cit.*, p. ix.
13. *Ibid.*, p. xiv.
14. *Ibid.*, p. xiii.
15. *Ibid.*, p. xx.
16. Oak Ridge Associated Universities, *Employment, Education and Training Implications of the National Energy Act*, prepared for the U.S. Department of Energy, Oak Ridge, Tennessee, April 1980, p. 102.
17. U.S. Department of Energy, "Response Plan: Reducing U.S. Impact on the World Oil Market," Washington, D.C., April 1979, p. 6.
18. White House Press Office, *op. cit.*
19. John Short and Associates, Inc., "A Study to Determine the Manpower and Training Needs of the Coal Mining Industry," draft report to the U.S. Department of the Interior, Bureau of Mines, Salt Lake City, Utah, December 1979, p. 73.
20. *Ibid.*
21. Bechtel National, Inc., *Projected Annual Resource Requirements at the National and Regional Level*, for the Department of Commerce Energy Forecast 1985 and 2000, San Francisco, California, 1977, pp. 5-12 (appendix).
22. *Ibid.*
23. Oak Ridge Associated Universities, *op. cit.*, pp. 37-39.
24. *Ibid.*, p. 38
25. *Ibid.*, p. 107.
26. *Ibid.*
27. Council on Economic Priorities, *Jobs and Energy*, New York, New York, 1979, p. 11.
28. Daneker, Gail, and Grossman, Richard, *Energy, Jobs and the Economy*, Boston, Massachusetts, 1979, p. 17.
29. Oak Ridge Associated Universities, *op cit.*, p. 109.
30. *Ibid.*, p. 85.
31. Information Dynamics, Inc., *Meeting Energy Workforce Needs*, Silver Spring, Maryland, 1980, p. 42.
32. Daneker and Grossman, *op. cit.*, p. 70.
33. *Ibid.*, p. 71.
34. Oak Ridge Associated Universities, *op. cit.*, p. 110.
35. *Ibid.*, p. 108.
36. *Ibid.*
37. Information Dynamics, Inc., *op. cit.*, p. 214.
38. *Ibid.*, p. 99.
39. *Ibid.*, p. 101.
40. *Ibid.*, pp. 105-106.
41. *Ibid.*, p. 97.
42. *Ibid.*, p. 215.
43. *Ibid.*, p. 302.
44. *Ibid.*
45. *Ibid.*, p. 303.
46. *Ibid.*
47. *Ibid.*
48. Oak Ridge Associated Universities, *op. cit.*, pp. 104-105.
49. *Ibid.*, p. 109.

Bibliography

Blair, Larry M., *et. al.* "Community Level Employment and Income Impacts of Biomass Energy Development and Use." A working paper on a pilot case study. Oak Ridge: Oak Ridge Associated Universities, October 1979.

_____ . *Solar Energy Employment Information from Case Studies.* Oak Ridge: Oak Ridge Associated Universities, December 1978.

Blair, Larry M., and Doggette, John. "Education, Training, and Work Experience Among Nuclear Power Plant Workers." International Symposium on Manpower Requirements and Development for Nuclear Power Programmes, Saclay, France, April 1979. Oak Ridge: Oak Ridge Associated Universities, 1979.

Bio-Energy Directory, edited by Paul F. Bente. Washington, D.C.: Bio-Energy Council, April 1980.

Corcoleotes, George, *et. al. National Solar Energy Education Directory,* 2nd ed. Golden: Solar Energy Research Institute, January 1980.

Council of Jewish Federations and Rice & deBoinville. *Compendium of Federal Programs Related to Community Energy Conservation.* Prepared for the U.S. Department of Housing and Urban Development, Office of Neighborhoods, Voluntary Associations, and Consumer Protection. Washington, D.C.: Rice & deBoinville, February 1979.

Development Sciences, Inc. "Education and the Energy Crisis: Policies and Actions for the Department of Energy." Washington, D.C.: DSI, January 22, 1980.

Daneker, Gail, and Grossman, Richard. *Energy, Jobs and the Economy.* Boston: Alyson Publications, Inc., 1979.

Energy Future, edited by Robert Stobaugh and Daniel Yergin. A report of the Energy Project at the Harvard Business School. New York: Random House, 1979.

Energy Resource Guide, edited by Jacqueline E. Woods. Washington, D.C.: National Council for Resource Development, 1980.

Executive Office of the President. "National Energy Plan." Washington, D.C.: Energy Policy and Planning, April 1977.

Executive Office of the President. "National Energy Policy—Background Report." Washington, D.C.: White House Press Office, July 1, 1980.

Finn, Michael G. *Employment, Education and Training Implications of the National Energy Act.* Oak Ridge: Oak Ridge Associated Universities, April 1980.

Gunn, Anita. *Sources of Fund$ for Solar Activities,* 2nd ed. Washington, D.C.: Center for Renewable Resources, 1979.

Hamilton, Bette Everett. "Survey of Energy Programs in Two-Year Colleges and Technical Institutions." Washington, D.C.: American Association of Community and Junior Colleges, December 1978.

Hull, Daniel M. *Energy-Related Training Activities.* An assessment of current offerings throughout the country. Waco: Technical Education Research Centers, Inc., December 29, 1978.

Jobs and Energy. The employment and economic impacts of nuclear power, conservation, and other energy options. New York: Council on Economic Priorities, 1979.

John Short & Associates. "A Study to Determine the Manpower and Training Needs of the Coal Mining Industry." A draft report to the U.S. Department of the Interior, Bureau of Mines. Salt Lake City: John Short & Associates, December 1979.

Lovins, Amory B. *Soft Energy Paths.* New York: Harper Colophon Books, 1977.

Mahoney, James R. "Energy Education Program Development in Two-Year Post-secondary Institutions—A Look at National Surveys." Washington, D.C.: American Association of Community and Junior Colleges, ERIC #181-980, January 1980.

_____ . "What Do Chickens, Alcohol, and Windmills Have to Do With Community Colleges?" *Community and Junior College Journal,* Vol. 50, No. 8 (May 1980).

Meeting Energy Workforce Needs: Determining Education and Training Requirements. Silver Spring: Information Dynamics, Inc., 1980.

National Research Council of the National Academy of Sciences. *Energy In Transition 1985-2010.* San Francisco: W.H. Freeman and Company, 1979.

Resources for the Future. *Energy—The Next Twenty Years*. A report sponsored by the Ford Foundation. Cambridge: Ballinger Publishing Company, 1979.

Schachter, Meg. "Job Creation Potential of Solar and Conservation: A Critical Evaluation." Report to the U.S. Department of Energy, Advanced Energy Systems Policy Division. Washington, D.C.: U.S. Department of Energy, November 26, 1978.

Schurr, Sam H., *et. al. Energy in America's Future: The Choices Before Us*. A study prepared for the RFF National Energy Strategies Project. Baltimore: The Johns Hopkins University Press, 1979.

Stevenson, Wayne. "Employment, Education, and Recent Energy Legislation." Oak Ridge: Oak Ridge Associated Universities, February 1980.

Time to Choose: America's Energy Future, 4th ed. Final report by the Energy Policy Project of the Ford Foundation. Cambridge: Ballinger Publishing Co., 1976.

Toffler, Alvin. *The Third Wave*. New York: William Morrow and Company, Inc., 1980.

U.S. Congress, Congressional Budget Office. *Energy Development, Local Growth, and the Federal Role*. Washington, D.C.: U.S. Government Printing Office, June 1980.

U.S. Congress, Joint Economic Committee. "Employment Impact of the Solar Transition." Washington, D.C.: U.S. Government Printing Office, April 6, 1979.

U.S. Department of Commerce. *Projected Annual Resource Requirements at the National and Regional Level*. Energy forecast for 1985 and 2000. San Francisco: Bechtel National Inc., 1977.

U.S. Department of Education, Energy and Education Action Center. "Selected Guide to Federal Energy and Education Assistance." Washington, D.C.: U.S. Department of Education, 1979.

U.S. Department of Energy, Division of Advanced Energy Systems Policy. *Creating Jobs Through Energy Policy*. Washington, D.C.: U.S. Government Printing Office, July 1979.

_____ Education Division. "Coal Task Force Report on Education and Training." Draft report. Washington, D.C.: U.S. Department of Energy, January 1979.

_____ Energy Information Administration. *EIA Publications Directory*. Washington, D.C.: Energy Information Clearinghouse, February 1980.

_____ Energy Information Center. *Energy Information Referral Directory*. Washington, D.C.: National Energy Information Center, January 1980.

_____ Office of Public Affairs. *Professional Energy Careers*. Washington, D.C.: U.S. Department of Energy, May 1979.

_____ Office of State and Local Assistance. "Comprehensive Program & Plan for Federal Energy Education, Extension & Information Activities." Third report to Congress. Washington, D.C.: National Technical Information Service, March 1980.

_____ "Response Plan: Reducing U.S. Impact on the World Oil Market." Washington, D.C.: U.S. Department of Energy, April 1979.

"Wingspread Conference on Energy Education," edited by John Thoman. Review of the status of energy education in Wisconsin with goals and program suggestions. Racine: State Division of Energy, 1979.